Morpho Physiological Traits of Some Rice Varieties in Response to Shallow Water Depth

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A B S T R A C T

A field experiment was conducted at the Adaptive Research Station, Sakhigopal, Puri during kharif-2012 to study the morpho-physiological basis of yield variation in the newly released rice genotypes. Nine rice genotypes such as Tanmayee, Mrunalini, Tejaswini, Swarna, OR-2327-23, OR-2324-8, Pratikhya, Hiranmayee and Swarna sub-1 were taken into test under shallow water depth condition in the field in a randomised block design (RBD) in three replications. In the present study, higher grain yield was obtained in Tanmayee due to more number of spikelet/panicle, ripened grain/panicle, less number of sterility percentage and total number of spikelet/panicle. On the contrary, lower value of the above characters reduced the grain yield in Swarna sub-1. The 1000-Grain weight was found to be maximum 26.4gm in Tanmayee and minimum value of the same was exhibited by Tejaswini (18.8gm). The number of chaffs/panicle was found to be minimum (9.1) in Swarna whereas, the maximum value of the same was observed in OR-2324-8 (12.7). Partitioning of photosynthates into grains as measured in terms of HI showed maximum value (36.2%) in Tanmayee which was significantly greater than Swarna sub-1, OR-2327-23 and OR-2324-8. On the other hand, Hiranmayee exhibited the minimum value of the same (32.5%) being at par with Swarna sub-1.

Introduction

Rice is an important food grain for the majority of the world population as well as of India. It provides about 31% and 17% of the total calories and protein requirement respectively for which it is considered as a staple food of (88.2%) of Indian population. Among the rice growing countries India has the largest area 100m.ha under rice in the world. In respect of production India stands second with 103m. tons of paddy which is 22.25% of the total world production. However, the average yield potentiality in India is lowest, 2.3tons/ha. In India rice is grown in almost all the states under widely varying conditions of altitudes and climates. Its cultivation in India is extended from $19^048'$N latitude from the sea level to as high as 6 metres. The present global population is

expected to reach 8billion by 2020 and to 8.1billion by 2050AD. More than 96% of the population increase will take place in the Asian countries where more than 90% rice is produced and consumed. Considering the increasing population growth of India the expected rice requirement must be reached to a level of 160million metric tons by 2050AD, but; Paroda (2006) informed that rice production level in India is almost stagnant for the last six years. So in order to feed to the ever increasing population under reduced area declining impact use efficiency having limited irrigation facilities in rainfed ecosystem the suitable variety should be cultivated in respective lands in appropriate time but; due to the biotic and abiotic stresses the genetic potentiality of a crop variety is limited (Oreka, 1999). Rice primarily a highly energetic, high calorie food. This is a major source of protein in Asian diet. The protein content of milled rice is usually 7.3%. Among the cereals, it has high protein quality. It is relatively rich in lysine which is a commonly limiting essential amino acid of cereals. During milling much of the fat is lost for which the fat content of rice is very low (2-2.5%). Like wheat crop rice grain contains much of B-group of vitamins. Milled rice losses valuable proteins, vitamins and minerals in the milling processes during which the embryo and aleurone layer is removed, which can be avoided through boiling process. Besides the grain utility by product of rice milling are used for a variety of purposes. For cattle and poultry feedings rice bran can be used, whereas, for manufacturing of insulating materials rice hulls can also be used. Now a days rice bran oil is being manufactured. Yield variation in different rice genotypes of rice is governed by both genetic and environmental factor. These two factors influence the growth, development, yield and its attributing characters as well as biochemical changes in rice.

Materials and Methods

A field experiment on rice was conducted during *kharif* 2012 in the Adaptive Research Station, Sakhigopal, Puri to study the mopho physiological characters responsible of the rice genotypes under shallow water depth condition which are related for yield of the crop. The Adaptive Research Station, Sakhigopal is situated in 19°48' North Latitude and 85°52' East Longitude and 20 kms away from Bay of Bengal with an altitude of 6m above the mean sea level. The climate is relatively warm and humid in nature with short mild winter. The average annual rainfall of Sakhigopal is 1408.8mm which is received from South-West monsoon during 2012.the total precipitation was about 1405 mm which has been received from June to December. The date of sowing in the nursery bed was conducted from 7th June, 2012. The nursery bed was developed for planting of six varieties of rice as mentioned above. Required amount of FYM and phosphatic fertilizers were well mixed with the soils of nursery for development of fertility of soil, before date of sowing. The six varieties were sown by in lines with keeping appropriate spacing between the varieties. The irrigation channels were kept surrounding the speed beds. Frequent sprinkler irrigation was given for seedbed initially and after germination irrigation management was done in such a manner that the raised seed bed remained moistened without any standing water over its surface for one week. Thereafter standing water was maintained up to 3cm for the better growth of seedlings minimum N-fertilizer was given in seed bed. Before 7 days of rooting of seedling granular pesticide as per as recommendation was applied in seed bed in order to avoid the infection of disease and pest after the transplanting. After 30 days of sowing the seedling was up rooted for transplanting. Before transplanting of seedlings and basal

dose of 25kgN, 30Kg P_2Os and 30 Kg K_2O per hectare were applied and mixed thoroughly in soil during piddling. Rest nitrogen was top dressed twice. The first top dressing of nitrogen @30Kg/ha in the form of Urea was applied after 15 days of transplanting. The second top dressing of nitrogen @ 25kg/ha in the form of Urea was applied at 112 days after transplanting. Thirty days old seedlings of rice genotypes were transplanted in the main field on 07.07.2012 with a spacing of 20cm x 15cm having two seedlings per hill. To study the genotypic variation in physiological growth parameters, 3 hills occupying an area of $600cm^2$ were uprooted at 17th and 31st day of transplanting. Plants were washed thoroughly and different parts of the plant were separated. Leaf area was measured by multiplying apparent leaf area with the leaf area factor. Leaves and other portions of the shoot were kept separately in paper bags and dried in an oven at 90^0C for 48 hours. The dry weight of the planting materials was recorded. Then the physiological growth parameters such as CGR, RGR, NAR and RLGR were calculated using the following formulae. Also at 50% flowering the other physiological growth parameters like LAR, LWR, SLA, SLW AND LAI were computed. For counting of tillers, three hills were tagged initially in each replication of the genotypes then the tillers were counted at 5 days interval till heading.

Results and Discussion

Comparison of plant height between the genotypes of rice revealed that there was significantly wide variation in plant height ranging from 108.9cm in OR-2324-8 to 125.2cm in Mrunalini (Table 1). The plant height of Tanmayee and Swarna sub-1 was at par with Swarna and OR-2327-23. Tejaswini and Hiranmayee had more or less similar height 118.1 and 118.2cm. Plant height depends on the inter nodal elongation which

is closely associated with growth duration (Hosoda and Twasakie, 1960; Vergara *et al.,* 1965). As it is a medium duration rice genotype it usually stars around panicle primodia initiation stage. Due to shallow water depth there was synthesis of ethylene which enhances GA production for which there is rapid cell division as a result of which inter node elongation was more and height of the plant was increased after the vegetative stage. The present finding correlates with the previous findings.

In rice plant tillers are developed from the leaf axils at each unelongated node of the main shoot or from other tillers during vegetative growth. The number of tillers/hill is directly correlated with the duration of vegetative period and uptake of phosphorus. In the present study it was revealed that total number of tillers/hill was highest in Tanmayee (10.8) and lowest in Swarna sub-1(7.5) (Table 1).

Among the yield components, effective (productive) tillers hill[-1] are very important, the yield is mainly a function of panicle bearing tillers per unit area (Baloch *et al.,* 2006). Data presented in (Table 1) exhibited that the maximum effective tillers hill[-1] was in Tanmayee (6.9), whereas, Swarna sub-1showed lowest value of the same (5.1). Significant variation was also noted among the genotypes. Varietal difference in respect of effective or productive tillers and their positive correlation with rice grain yield has already been documented and reviewed earlier (Gawai *et al.,* 2006; Das and Baruah, 2007) which corroborates with the present findings.

At a given time, the rice plant is composed of leaves that are physiologically different in age and activity. Before the panicle initiation stage in rice a leaf emerges about every 4-5 days interval and afterward it takes about 7-8

days. Leaf area index is an important determinant of growth and yield. The critical LAI value at maximum crop photosynthesis is about 5-6 under normal conditions. In the present study it was found that there was wide variation in LAI among the genotypes of rice ranging from 5.1 to 6.8 (Table 1). Among the genotypes Tanmayee exhibited maximum LAI followed by Mrunalini. On the other hand, Swarna sub-1 showed lowest value of the same. Mandal and Chattargy (1973) recorded the maximum LAI in rice which range from 5 to 8 among the genotypes which corroborate with the present findings. Comparison of SLA between the genotypes revealed that Mrunalini exhibited significantly higher SLA ($246.7 cm^2$ gm^{-1}) than other genotypes whereas, Hiranmayee showed the lowest value ($192.7 cm^2$ gm^{-1}) of the same (Table 1). According to Murata (1975) a wide variation in SLA among the genotypes in rice (200 to $400 cm$ gm^{-1}) was fond which agreed the present findings.

Specific leaf weight (SLW) of the genotypes exhibited the reverse trend as observed in case of SLA. It was indicated that Hiranmayee showed significantly higher SLW ($5.2 mg$ cm^{-2}) where the minimum value of the same was exhibited by Tanmayee ($4.0 mg$ cm^{-2}).

Comparison of LWR among the genotypes revealed that Swarna had the highest LWR ($0.43 gm$ gm^{-1}) whereas; Hiranmayee exhibited the lowest value ($0.33 gm$ gm^{-1}) of the same (Table 1). Mrunalini, Tejaswini and Pratikhya exhibited the same value ($0.39 gm$ gm^{-1}) among the genotypes.

Similarly varietal difference in LAR indicated that Tanmayee showed the maximum LAR ($58.0 cm^2$ gm^{-1}) being significantly higher than all the other genotypes. On the other hand, OR-2324-8 exhibited the lowest value ($53.0 cm^2$ gm^{-1}) of the same which is at par with Tejaswini ($53.8 cm^2$ gm^{-1}).

The Relative growth rate (RGR) of the genotypes varied from 31.0 to 35.8 mg gm^{-1} day^{-1} (Table 2). In general, the highest RGR was exhibited by Mrunalini (35.8mg gm^{-1} day^{-1}) followed by Tanmayee (35.7mg gm^{-1} day^{-1}) whereas, the lowest value of the same was showed by Hiranmayee (31.0mg gm^{-1} day^{-1}).

Many reports envisage that NAR is positively associated with SLW but negatively with LAR. Therefore, SLW is considered as a useful tool for selection of genotypes for higher NAR-rice activities (Chatha and Khan, 1991; Murty and Pattnaik, 1986). The variation of NAR among the genotypes ranged from 35.2 to 49.5mg/dm^2/day (Table 2).

Among the genotypes Tanmayee, Mrunalini and Tejaswini exhibited higher NAR than the other genotypes whereas, lowest value of the same was noted in OR-2327-23. The crop growth rate (CGR) of the genotypes showed that Mrunalini had the maximum CGR (13.6gm/m^2/day) whereas, the minimum value (11.5gm/m^2/day) was recorded in OR-2324-8 (Table 2).

The CGR of Swarna sub-1, Hiranmayee and Swarna were greater than other genotypes except sited above. Comparison of CGR among the genotypes revealed that Mrunalini had the highest RLGR (34.0mg/gm/day) whereas; OR-2324-8 exhibited the lowest value (26.0mg/gm/day) of the same (Table 2).

There was variation in Leaf area duration (LAD) among the genotypes ranging from 108.7 days in Swarna sub-1 to 118.6 days in Tanmyee (Table 2).

It has been shown to correlate highly with yield (Gardener *et al.,* 1988). It is because biomass duration (B.M.D) is analogous to LAD of which LAI/leaf area is determinant.

Table.1 Variation in growth characters among the rice genotypes

Variety	Plant height (cm)	Total no. of tillers/hill	No. of Effective tillers/hill	LAI	SLA (cm^2/g)	SLW (mg/cm^2)	LWR (g/g)
Tanmayee	120.8	10.8	6.9	6.8	239.1	4.0	0.38
Mrunalini	125.2	9.1	6.2	6.7	246.7	4.3	0.39
Tejaswini	114.1	8.0	5.8	6.3	222.6	4.4	0.39
Swarna	118.1	8.4	5.7	6.0	218.0	4.5	0.43
OR-2327-23	118.6	7.5	5.4	5.7	211.0	4.5	0.37
OR-2324-8	108.9	7.9	5.7	5.4	208.7	4.6	0.36
Pratikhya	117.1	7.7	5.6	5.3	205.3	4.6	0.39
Hiranmayee	114.2	7.8	5.3	5.2	192.7	5.2	0.33
Swarna sub-1	119.7	7.5	5.1	5.1	206.0	4.8	0.35
Mean :	132.0	9.0	7.0	7.0	216.16	5.0	0.37
SEM :	1.704	0.179	0.318	0.055	3.244	0.068	0.009
CD 5%	4.771	0.502	0.890	0.154	9.082	0.191	0.027
CV %	2.23	3.33	8.45	1.37	2.29	2.31	4.64

Table.2 Variation in Pre-flowering photosynthate translocation to grain (PPTG), Post-flowering photosynthate contribution to grain (PPCG and growth attributing characters) in rice genotypes

Variety	PPTG (%)	PPCG (%)	NAR (mg/dm^2/day)	CGR (g/m^2/day)	LAD (days)	LAR (cm^2/g)	RGR (mg/g/day)	NAR (mg/dm^2/day)
Tanmayee	26.5	73.4	49.5	13.0	118.6	58.0	35.7	49.5
Mrunalini	22.5	77.5	48.8	13.6	115.3	56.7	35.8	48.8
Tejaswini	21.5	78.4	46.2	13.2	113.3	53.8	34.3	46.2
Swarna	24.1	75.6	42.7	12.8	111.2	56.9	33.3	42.7
OR-2327-23	24.0	76.0	35.8	12.1	110.5	54.6	33.7	35.8
OR-2324-8	23.7	76.1	37.2	11.5	111.4	53.0	32.9	37.2
Pratikhya	24.6	75.5	38.8	12.0	111.2	56.6	32.8	38.8
Hiranmayee	22.3	78.1	41.4	12.8	110.2	57.7	31.0	41.4
Swarna sub-1	28.3	71.7	42.7	12.4	108.7	55.8	31.6	42.7
Mean :	27.0	85.0	42.56	12.60	112.26	49.6	38.0	42.56
SEM :	0.151	0.127	0.381	0.167	0.176	0.727	0.237	0.381
CD 5%	0.423	0.355	1.067	0.468	0.513	2.035	0.664	1.067
CV %	0.96	0.26	1.38	2.05	0.86	2.0	1.09	1.38

Table.3 Variation in yield attributing characters among the rice genotypes

Genotypes	1000-Grain weight (g)	Harvest Index (HI)	Grain yield (qt/ha)	Panicle Length (cm.)	Total no. of Grains/panicle	Total no. of Matured Grains/panicle	No. of Chaffy grains/panicle	Sterility %
Tanmayee	26.4	36.2	47.0	21.3	107.4	96.3	11.1	10.3
Mrunalini	23.7	35.5	43.0	22.6	99.4	88.0	11.4	11.5
Tejaswini	18.8	35.2	37.7	23.0	86.1	74.3	11.8	13.7
Swarna	22.4	34.4	35.0	20.5	72.7	63.6	9.1	12.5
OR-2327-23	27.2	33.4	36.4	20.4	84.9	73.1	11.8	13.9
OR-2324-8	22.1	33.1	34.4	21.4	89.4	14.1	12.7	14.1
Pratikhya	22.3	35.1	33.0	21.1	84.7	72.9	11.9	13.3
Hiranmayee	22.5	32.5	30.3	22.9	79.5	68.2	11.3	14.2
Swarna sub-1	21.7	32.7	28.1	20.3	75.1	65.6	9.5	12.7
Mean :	26.0	39.0	41.0	21.3	86.57	85.0	11.17	12.91
SEM :	0.305	0.363	1.010	0.369	0.706	18.876	0.167	0.182
CD 5%	0.855	1.017	2.828	1.033	1.978	52.849	0.467	0.511
CV %	2.04	1.63	4.31	2.64	1.26	38.53	2.30	2.17

Comparison in pre-flowering photosynthates translocation to grain (PPTG) and Post-flowering photosynthates contribution to grain yield (PPCG) among the genotypes indicated that Swarna sub-1 had maximum Pre-flowering photosynthates to grain (PPTG) (28.3%) whereas, the same was minimum (21.5%) in Tejaswini (Table 2). However, variation in Post-flowering photosynthate contribution to grain yield (PPCG) among the genotypes followed the reverse trend as observed in case of PPTG (Table 2).

Further it was found that Pre-flowering photosynthates translocation to grain (PPTG) and Post-flowering photosynthates contribution to grain yield (PPCG) showed significant correlation with grain yield. The present study is consonance with the findings of the earlier workers (Guru, 1992; Sircar and Das, 1974). It was reported that, more than 70% of dry matter produced after flowering was utilized to produce grain yield in the improved genotypes of rice whereas, in the tall genotypes less than 70% of the dry matter contributed to this component.

Yoshida (1972) observed that the contribution of pre-heading storage of photosynthates into grain yield of rice is variable ranging from (20-40%).

Partitioning of photosynthates into grains as measured in terms of HI showed maximum value (36.2%) in Tanmayee which was significantly greater than Swarna sub-1, OR-2327-23 and OR-2324-8 (Table 3). On the other hand, Hiranmayee exhibited the minimum value of the same (32.5%) being at par with Swarna sub-1.

Yield component that influence the grain yield of a genotype at constant population are 1000-Grain weight, Number of ripened grains/panicle and Number of panicles per unit land area. Out of these last two components consequently determine the ripened grains per unit area. In the present study, higher grain yield was obtained in Tanmayee due to more number of spikelet/panicle, ripened grain/panicle, less number of sterility percentage and total number of spikelet/panicle. On the contrary, lower value of the above characters reduced the grain yield in Swarna sub-1. The 1000-Grain weight was found to be maximum 26.4gm in Tanmayee and minimum value of the same was exhibited by Tejaswini (18.8gm) (Table 3). The number of chaffs/panicle was found to be minimum (9.1) in Swarna whereas, the maximum value of the same was observed in OR-2324-8 (12.7).

Comparison of grain yield between the genotypes of rice revealed that there was a wide variation in grain yield among the genotypes ranging from 28.1 to 47.0qt ha^{-1} (Table 3). Among the genotypes Tanmayee exhibited grain yield followed by Mrunalini whereas, lowest yield was contributed by Swarna sub-1. The grain yield of all the genotypes varied in the following order.

Tanmayee > Mrunalini > Tejaswini > Swarna > OR-2327-23 > OR-2324-8 > Pratikhya > Hiranmayee > Swarna sub-1.

In the present study, higher grain yield was obtained in Tanmayee due to more number of spikelet/panicle, ripened grain/panicle, less number of sterility percentage and total number of spikelet/panicle. On the contrary, lower value of the above characters reduced the grain yield in Swarna sub-1. The 1000-Grain weight was found to be maximum 26.4gm in Tanmayee and minimum value of the same was exhibited by Tejaswini (18.8gm). Partitioning of photosynthates into grains as measured in terms of HI showed maximum value (36.2%) in Tanmayee which was significantly greater than Swarna sub-1, OR-2327-23 and OR-2324-8.

References

Baloch Mahammad Safdar,Anayanta Ullah Awan and Gul Hassan (2006).Growth and yield of rice affected by transplants dates under high temperature of Dera Ismal Pakistan, Publish online,June-16.

Chattha, T.M and khan, M.A. (1991).Study on relationship between physiological parameters of indices. Pakistan Journal of Scientific and Industrial Research 34(1):37-39.

Gawai, M.P., Veer, K.T., and others (2006). Genetic variability, correlation and path co-efficient in some promising lines of rice. *International Journal Plant Science Research* 33(1-4).

Guru, S. K., (1992): Studies on Physiological Variation in Some Rice Varieties. O.U.A.T.

Murata, Y.and Matsushima, S., (1975).Rice. In L. T. Evan (Editor), Crop Physiology. Cambridge University Press, Cambridge, pp.73-79.

Oerke, E.C.C., A Weber, W.H., Dehne, F., Schonbeck (1999). Crop Production and crop protection: Elsevier, Amsterdam.

Paroda R.S (2006). Strategy for increasing productivity growth rate in agriculture. PIB Government of India online information.30:11.

Yoshida, S. (1981).Fundamental of Crop Science.Intl.Rice Res. Inst., Los Banos, Leguna, Philipines. 269 Pp.